The method and the interest of the facts brought to light by it will be clearer from two short examples.

Amount of precipitate obtained by adding anti-human serum to the serum of man and apes (expressed as percentages):—

Man	100
Ourang	80
Cynocephalus mormon	50
Cercopithecus petaurista	50
Ateles vellerosus	25

Amount of precipitate obtained in a similar way by adding anti-horse serum to the serum of horse, donkey, zebra:—

Equus caballus	100
Equus asinus	84
Equus grevyi	58

Tested in this way the indications of blood relationship between man and the ourang are comparable to those between the horse and the donkey. The serum of other mammalia gave but traces of precipitate with the above anti-sera, and that of other vertebrates none at all.

In these precipitin-phenomena we have perhaps a really physiological test of blood relationship, and that, as the author suggests, "a common property has persisted throughout the ages which have elapsed during the evolution of animals from a common ancestor in spite of differences of food and habits of life." Anomalies do undoubtedly occur when working with any particular anti-serum, so that all conclusions must be controlled by experiments with anti-sera prepared from different individuals. Section viii. contains the results of 2500 similar tests, undertaken by Graham Smith, in the application of the method to the lower vertebrates and invertebrates. These will be of no less interest to zoologists, but space prevents our entering upon further particulars.

The ninth and last section deals with the practical application of precipitin reactions to legal medicine. As the precipitable substance in sera is a relatively stable body, is very resistant to the action of putrefactive organisms, and is not destroyed by drying, the detection of human blood by this means is not confined to stains of recent origin. Indeed, Graham Smith and Sangar have examined a large number of articles from the collection of the Criminal Investigation Department, Scotland Yard, and have succeeded in identifying human blood stains which were thirty years old.

The fact that anti-human serum forms precipitates to some extent when added to the serum of monkeys does not seriously diminish the forensic value of the precipitin test for human blood, for the plea that suspected bloodstains were of simian origin would seldom be raised and hardly ever substantiated.

The volume concludes with an excellent bibliography on precipitins and allied subjects which occupies sixteen pages!

In addition to containing the methods and experimental results whereby the author and his associates, Drs. Graham Smith and Sangar, have tested and developed the precipitin reaction as an indication of blood relationship, the book contains practically all that is known on the subject of precipitins up to the present time, and will therefore be indispensable to anyone desiring to become acquainted with or to work upon this subject.

CHARLES J. MARTIN.

THE MOON.

The Moon. A Summary of the Existing Knowledge of our Satellite, with a Complete Photographic Atlas. By Wm. H. Pickering. Pp. xii + 102; 100 illustrations. (New York: Doubleday, Page and Co., 1903.) Price 10 dollars net.

IT has so long been taught that the moon is a world on which nothing ever happens that it may come as a surprise to many to learn that the probability of frequent changes in the lunar surface is now seriously advocated. The author of this book, who is a well known American astronomer, is convinced that there are daily alterations over small areas which cannot be explained either by shifting shadows or varying librations, and therefore infers that there are real changes in the surface detail. The observations on which this conclusion is based are collected in the present volume, which also includes a more general account of our satellite, and contains the first complete photographic atlas which has yet been published.[1]

To make a thorough study of the moon, Prof. Pickering some years ago suggested the use of a telescope of great focal length, and, as so frequently happens in America in such circumstances, the generosity of two anonymous donors enabled him to try the experiment. The instrument actually employed was a 12-inch objective of 135 feet focal length, giving a direct image of the moon nearly 16 inches in diameter, and to obtain the advantage of such "steady" atmospheres as can only be found in low latitudes it was taken out to Jamaica and set up at Mandeville, 2080 feet above sea-level. The long telescope tube was erected on the side of a convenient hill with its axis in the direction of the pole, and light was reflected into it at the lower end by a clock-driven mirror. The instrument was so far successful that all the negatives for the atlas were obtained within seven months.

The atlas shows the lunar surface in sixteen sections, each of which is exhibited under five different conditions of illumination, and there is in addition a good picture of the full moon, with the necessary key maps, besides other illustrations of interest. Although the photographs are not all of the finest definition, the completeness of the series gives them a special value, and the atlas will doubtless prove extremely useful to all who are engaged in lunar studies.

Apart from the photographs, the chief interest of the book lies in the observations and arguments which are put forward in favour of lunar activities. The moon is so near that no improbably great area need be affected to make a change visible to an observer on the earth, but any real variations are liable to be

[1] The atlas is also published in the *Annals* of the Harvard Observatory, vol. li., 1903.

masked by the varying conditions of illumination. This difficulty does not, of course, disappear even when series of photographs are under examination; in the words of the author (p. 91):—

"It was soon found that for certain regions, notably those in the northern half of the disc, the change in appearance produced by the difference of lighting rendered it absolutely impossible to identify the same formation upon the plates taken at (lunar) sunrise and sunset and those taken at noon."

Photographs at intermediate phases were accordingly taken, and by aid of these the connection can be traced.

Photographs, indeed, introduce another difficulty. Slight changes in exposure and development were found sometimes to produce very misleading results, and it is pointed out that the only safe procedure is to confirm all suspected changes by extended observations under different conditions with the telescope. There is, however, no reason to suppose that the author is unfamiliar with the many pitfalls, and the interesting results of his labours may therefore be received with some confidence, or at least as demanding careful investigation by other observers.

Attention was directed by the author ten years ago to the variability of many of the dark spots which are dotted over the lunar surface, the three in Alphonsus being probably familiar to most observers. The view then expressed that these are patches of organic growth resembling vegetation, which spring up and die during the long lunar day, still seems to give the only simple explanation of the appearances observed. The spots are said to be darkest near full moon, when shadows are geometrically impossible, and a real change in the reflecting surface therefore seems to be highly probable.

On the question of active lunar craters, the chief facts relating to Plato and the much discussed case of Linné are summarised, and an account is given of phenomena observed in the crater forming the source of Schroter's valley which bear a striking resemblance to those accompanying the active eruption of a terrestrial volcano. Part of the description reads:—

"Dense clouds of white vapour were apparently rising from its bottom and pouring over its south-western crater wall in the direction of Herodotus" (p 40).

The changes in this "vapour column" are said to be visible with a 6-inch telescope under ordinary atmospheric conditions, so that the reality of the phenomenon need not long remain in doubt, whatever explanation may be adopted. The author evidently believes that there is an actual emission of vapour, and he points out that as water cannot exist as a liquid on account of the rarity of the lunar atmosphere, it would take the form of snow or hoar frost.

Many of the changing appearances of lunar details are, in fact, attributed to deposits of snow and hoar frost which melt under the influence of the sun's rays, and are re-deposited when those rays are withdrawn. Among other evidence that there is snow on the moon, two photographs of the full moon are reproduced, one representing it as ordinarily seen, while the other is intended to exhibit the principal snow-covered areas; as these are differently printed copies from the same negative, the illustration is anything but convincing in the absence of details as to the printing processes. Other examples are more satisfactory. Linné, for instance, is surrounded by a white halo, which is stated to be not only now permanently smaller than it was thirty years ago, but to change with the altitude of the sun in a manner analogous to the seasonal variations of the polar caps of Mars. In this case the author had the happy thought to inquire if there were any variation during a lunar eclipse, the idea being that the withdrawal of sunshine for a couple of hours or so might produce an appreciable increase in size. Such an enlargement appears to have been established at the Lowell Observatory in 1898, and by the author himself in 1899, 1902, and 1903; another observer, Mr. Saunder, however, seems to have been somewhat doubtful as to the reality of the slight increase which his measures indicated in the eclipse of 1903, and as his observations would make the halo twice as great as those which the author made on the same occasion, further observations of this kind are evidently desirable.

It is also considered probable that many of the remarkable changes which have long been recognised in the craters Messier and Messier A are to be accounted for by varying depositions of snow.

Permanent deposits of snow in the craters themselves are believed to furnish an adequate explanation of the striking brightness of such craters as Aristarchus, and even the long bright streaks, such as those which radiate from Tycho, are attributed to the same substance. The long streaks are considered to be composed of a multitude of smaller snow streaks issuing from small white craterlets, usually less than a mile in diameter, many of which show a tendency to occur along lines which are probably cracks or lines of weakness in the lunar surface.

The "riverbeds" and lunar "canals," which the author has detected, present many features of interest, and the latter may be of special importance in view of the light which they may throw on the nature of the corresponding features of the planet Mars.

While some of his researches tend to modify the prevalent idea that the moon is a dead world, the author has no revolutionary views to put forward as to the general character of the lunar formations. He says:—

"There seems, indeed, to be no feature found upon the moon which is not presented by the Hawaiian volcanoes, and there is no feature of the volcanoes that does not also have its counterpart upon the moon. Even the cause of the bright streaks upon the moon . . . is partly illustrated by Hawaii" (p. 25).

Sufficient has been said to indicate the interesting character of this work, but its value as a contribution to science can scarcely be gauged until independent observations of the unexpected phenomena have been made. It is fortunate that some of the investigations suggested are within range of very modest instruments, even as low as 4 inches aperture.